



Investigating the Mechanism of Marital Mortality Reduction: The Transition to Widowhood and Quality of Health Care

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**Investigating the Mechanism of Marital Mortality Reduction:
The Transition to Widowhood and Quality of Health Care**

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ABSTRACT:

While it is well known that the widowed suffer increased mortality risks, the mechanism of this survival disadvantage is still under investigation. This paper examines the quality of health care as a possible link between widowhood and mortality. It addresses whether the transition to widowhood affects the quality of care individuals receive and explores the extent to which these changes mediate the elevated mortality hazard for the widowed. A unique dataset of 475,313 elderly couples was compiled and followed up for up to nine years. We analyze six established measures of quality of health care in a fixed-effect framework to account for unobserved heterogeneity. Caregiving and acute bereavement during the transition to widowhood appear to distract individuals from taking care of their own health care needs in the short-run. However, being widowed does not have long-term detrimental effects on individuals' ability to sustain contact with the formal medical system. Moreover, the short-run disruption does not mediate the widowhood effect on mortality. Nevertheless, long after spousal death, men suffer from a decline in the quality of informal care, coordination between formal and informal care, and the ability to advocate and communicate in the formal medical settings. These findings illustrate women's centrality in the household production of health and identify important points of intervention in optimizing men's adjustment to widowhood.

Losing one's spouse is one of the most traumatic transitions during the life course (Hatch 2000; Thompson et al. 1984). It has been well documented that individuals suffer increased mortality risks following spousal death (Elwert and Christakis 2006; Hu and Goldman 1990; Lillard and Panis 1996; Lillard and Waite 1995; Martikainen and Valkonen 1996). While the survival disadvantages of becoming widowed conform to broader findings on the role of social support and social ties on mortality (Berkman and Syme 1979; House, Landis and Umberson 1988), the specific mechanism of this effect remains elusive. The bereavement literature has suggested that an array of biological and psychosocial factors may mediate the effect of spousal loss on mortality (Brown, House and Smith 2006; Irwin and Pke 1993; Kim and Jacobs 1993; Williams 2004). However, studies that directly investigate the precise social and biological mechanisms of the survival disadvantages of becoming widowed are rare.

Here, we examine quality of health care as a potential link between widowhood and survival. It has been suggested that becoming widowed may alter individuals' patterns of interaction with the formal medical system, which in turn may affect individuals' health and survival (Elwert and Christakis 2006; Iwashyna and Christakis 2003; Litwak 1985; Litwak and Messeri 1989). But this conjecture has not been rigorously evaluated. We use a unique longitudinal dataset of 475,313 elderly couples and ask two sets of related questions. First, do the patterns of health care use and the quality of health care individuals receive change when individuals lose their spouses? Moreover, how does the quality of health care vary at different *stages* of the transition to widowhood? Second, to what extent do these changes, if any, contribute to the elevated mortality risks in the widowed?

Investigating the patterns of changes in quality of health care surrounding the transition to widowhood and their effects on survival has significant theoretical and practical implications. It illustrates how the marital relationship, as one of the most prevalent and strongest dyadic ties in individuals' informal social network (McPherson, Smith-Lovin and Brashears 2006), regulates individuals' interaction with a macro-social institution, namely the formal medical system, and, as a result, affects important aspects of life chances such as health and survival. Formal institutions and primary groups serve

complementary and substitutive functions to fulfill individual needs (Litwak and Messeri 1989). The loss in one realm affects the functioning of the other. The bereavement literature has so far tended to focus on the effects of spousal loss on bereaved individuals and their primary groups but has paid little attention to the interplay of individuals and formal institutions¹. Practically, to the extent that quality of health care serves as a link between the transition to widowhood and survival, this investigation provides insights into the timing and methods of interventions that may attenuate the harmful consequences of widowhood.

In the following sections, we first discuss theoretical perspectives on how becoming widowed may alter patterns of health care use and quality of health care individuals receive. Gender difference is an intrinsic focus of the research on marriage and health and is therefore considered. The link between quality of health care and survival in older adults is also discussed. We introduce the data and statistical methods, and then present and discuss the findings.

QUALITY OF HEALTH CARE DURING THE TRANSITION TO WIDOWHOOD

The Effects of Becoming Widowed on Quality of Health Care

The married typically enjoy better health than the unmarried (Lillard and Panis 1996; Waite and Gallagher 2000). Two causal explanations, which emphasize the marital benefits and the crisis of marital disruption respectively, have been proposed to account for the marital advantages and can be applied to understand the quality of health care during the transition to widowhood (Wade and Pevalin 2004; Williams and Umberson 2004).

First, the marital-benefits perspective suggests that social control and social integration provided by the marital relationship discourage risky behavior and encourage healthful behavior (Laub, Nagin and Sampson 1998; Umberson 1987, 1992). To the extent that maintaining regular interaction with health care providers, following medical regimens, and performing self-care and self-monitoring are seen as fostering health, the married may be particularly motivated to engage in such activities. As a result, the married

may be better able to enjoy appropriate use of health care and better coordination of formal and informal care than the unmarried.

Spouses also provide instrumental support that enables appropriate use of health care. Spouses may serve as conduits of information for each other. Marriage generally expands one's social network. Consequently the married may have access to a larger and better referral network and may obtain more and better information on health and health care, which they can use to assess their own health conditions and evaluate treatment options (Iwashyna and Christakis 2003). Spouses may also serve as advocates for their partners during interactions with health care providers. Spouses may facilitate communication with health care providers and help evaluate treatment options during the interaction in the formal medical system. This function is especially important when the partners are incapacitated.

When spouses die, the benefits conferred by the marital relationship may be at least partially lost (Umberson 1992). The depletion of marital benefits may start before the actual death of the spouse (Prokos and Keene 2005; Utz et al. 2004). Among older adults, spousal death is typically preceded by episodes of serious illnesses. The declining health of the ailing spouse may render him or her incapable of providing instrumental support or motivating his or her spouse to maintain healthful behavior (Christakis and Allison 2006).

Second, the crisis perspective argues that the process of transitioning to widowhood redistributes household resources (Dunkin and Anderson-Hanley 1998; Shaw, Patterson and Semple 1997). Spousal illness prior to death diverts household resources away from the surviving spouse, who typically also bears the burden of caregiving. As a result, the surviving spouse's interaction with the formal medical system may be disrupted. The literature on bereavement adjustment of caregivers after the death of recipients of caregiving provides two opposite predictions. The relief model suggests that the death of the ailing spouse may relieve the surviving spouse of the burden of caregiving and thus refocus household resources on his or her own health care needs (Bernard and Guarnaccia 2003; Mullan 1992). On the other hand, the complicated grief model suggests that accumulated stress compromises the coping abilities of

the surviving spouse (Bernard and Guarnaccia 2003; Stroebe and Stroebe 1993). Complicated grief, coupled with the strain of adjustment to new roles and reconfiguration of the household, may distract the surviving spouse from taking care of his or her health care needs.

The arguments of the loss of marital benefits and the disruption caused by spousal death converge in their predictions regarding the trajectories of changes in health care use at some stages during the transition to widowhood. For example, the burden of caregiving and the incapacitation of the dying spouse typically occur at the same time; the acute bereavement and the loss of marital benefits due to spousal death coincide as well. The negative effects of these distinctive processes on quality of health care are hard to distinguish. On the other hand, it has been found that after two years of bereavement, most widows and widowers were able to adjust to their new roles (Lopata 1996). The crisis model predicts that the detrimental effects of spousal death on quality of care diminishes and disappears in the long term; whereas the explanation of loss of marital benefits suggests that these detrimental effects persist. By examining the trajectories of changes in quality of care, it is therefore possible to make some inferences regarding the independent effects of the loss of marital benefits and crisis of spousal death.

Gender difference

Gender difference is a traditional focus of the research on marriage. In the household division of labor, wives are traditionally charged with taking care of the health needs of household members (Harrison 1978; Stolzenberg 2001; Umberson 1992). In addition, wives are more likely than husbands to do the emotional work of maintaining the couples' social network (di Leonardo 1987; Hagestad 1986; Powers and Bultena 1976). It follows that husbands may suffer a greater loss in marital benefits in terms of quality of health care than wives when they become widowed. Husbands also have a more difficult time adjusting to the reconfiguration of the household and the management of daily tasks after becoming widowed (Gupta 1999; Utz et al. 2004).

Indeed, the bereavement literature has generally found that widowers suffered worse health outcomes than widows (Gove 1973; Helsing and Szklo 1981; Martikainen and Valkonen 1996; Stroebe

and Stroebe 1983). Our work here focuses on elderly couples – for whom the traditional gender roles are more salient than their younger counterparts (Rogers and Amato 2000) – and we expect that the transition to widowhood will have more detrimental effects on quality of care for men than for women. On the other hand, a few studies have failed to find gender differences in different dimensions of life after becoming widowed (Elwert and Christakis 2006; Schaefer, Quesenberry and Wi 1995). Therefore it needs to be empirically verified whether men would be worse off in terms of obtaining appropriate health care than women after spousal loss.

Quality of Health Care as a Mediator of the Widowhood Effect

Seventy-four percent of all deaths in the U.S. occurs in the population aged 65 or older (Hoyert, Kung and Smith 2005). The elderly are more likely to suffer from chronic illness, or often a combination of several chronic illnesses, than the younger population (Bos Van Den 1995; Wolff, Starfield and Anderson 2002). With the development of effective medical therapies in the past few decades, appropriate utilization of health care has become crucial in maintaining health for the elderly (Christakis and Iwashyna 2003; Cutler 2004; Rowe 1985; Wang et al. 2007). If individuals tend to neglect their health care needs during the time surrounding the transition to widowhood, it is natural to ask whether and to what extent this neglect contributes to the adverse health outcomes and elevated mortality suffered by the widowed. Hence, a second goal of present research is whether any decrement in health care quality observed as a result of having a sick or dead spouse plays a role in a person's elevated mortality risk during the period after becoming widowed.

With a few exceptions (Iwashyna and Christakis 2003; Prigerson, Maciejewski and Rosenheck 1999), there has not been systematic research on how marriage or widowhood *per se* influences individuals' interactions with the health care system. To our knowledge, no studies have examined quality of health care as a mediator between widowhood and mortality. Prior work has explored cross-sectional correlations between marital status and health care utilization and suggested that married individuals enjoy better quality of health care than the widowed (Chin and Goldman 1997; Goodwin et al. 1987;

Iwashyna and Christakis 2003; Lannin et al. 1998; Mark and Paramore 1996; Prigerson et al. 1999; Sox et al. 1998). However, the causal direction and mechanisms are less than clear in these cross-sectional studies. In particular, married couples tend to share similar living environment and lifestyle. To the extent that characteristics of the shared environment or lifestyle lead to both low quality of health care and spousal death, we might observe a correlation between low quality of health care and being widowed if we compare the use of health care of those who do and do not experience spousal death. That is, the potential selection process out of marriage, rather than the casual effects of becoming widowed, might account for the observed correlation. Moreover the same selection process might also confound the assessment of the widowhood effect on the morality of the surviving spouse. This paper therefore takes a fixed effect approach that compares the same individuals before and after spousal death, which accounts for all observed and unobserved traits that are stable over time.

DATA AND METHODS

Data

We compiled Medicare claims data to obtain a very large cohort of elderly couples. First we used the Medicare Denominator File, which captures 96% of all elderly Americans, to identify Medicare beneficiaries who were 65 years of age or older as of January 1, 1993. Specially developed algorithms were then used to identify married couples (Iwashyna et al. 2002; Iwashyna et al. 1998); out of an estimated 6.6 million couples of which both spouses were older than 65, we identified 5,496,444 couples (83%). Past research shows that these couples were representative of all married couples who were 65 years of age or older in the U.S. in terms of socio-demographic characteristics (Iwashyna et al. 2002). Eighty-nine percent of these were between the ages of 65 and 98 years and resided in the United States. From this group, we drew a random sample of 518,240 couples (11%). Individuals enrolled in Medicare managed care plans were excluded from the analytical sample because the data on health care utilization are not complete for these individuals. Our primary analytical sample consisted of 475,313 couples.

This paper combines multiple datasets provided by Center for Medicare and Medicaid Services. The Vital Status File provided complete, daily follow-up of mortality status through January 1, 2002; this information allowed us to construct precise time-dependent measures of widowhood and mortality status. We obtained inpatient and outpatient claims for our sample for a nine-year period from 1993 to 2001, which provided diagnostic details and information on health care use. We used these data to construct time-varying measures of health care use and quality; the construction of these measures is discussed in more detail below. The Denominator File provided information on baseline demographic characteristics.

Quality of Care Measures

Quality of care is a multidimensional concept (Brook, McGlynn and Cleary 1996). We focus on two types of quality of care measures that are sensitive to patient agency and advocacy. These measures of quality are consequential to health outcomes in and of themselves (Smith-Bindman et al. 2006 ; Wang et al. 2007). Here, in keeping with past work, we also take them to be *indicators* of various aspects of a broader concept of quality of health care (Cutler 2004).

The first type indicates whether certain processes of care are performed. We examine whether individuals received each of four recommended measures of preventive care and chronic care management at appropriate frequencies, including diabetic monitoring (hemoglobin A1_c testing² and diabetic eye examination), cancer screening (mammogram), and vaccinations (influenza vaccination). These measures do not typically involve medically urgent situations, and therefore patients have more control over their occurrence. Their occurrence indicates the ability of the patients to maintain appropriate and desirable contact with their health care providers. Existing consensus in the medical community has established relatively unequivocal recommendations as to the frequency of delivery of these services in eligible populations (Pham et al. 2005). Table 1 reports the eligibility criteria and expected annual rates of performance of these quality of care measures. For example, it has been recommended that women aged between 65 and 74 should have annual mammograms; the expected annual rate is therefore 100%. Medicare claims data have been used with great success to identify eligible populations and to detect and

time the delivery of these services. The methods used to identify the occurrences of these services have been previously evaluated and validated by other investigators (Pham et al. 2005).

The second type of measures examines the outcomes of health care provision. We use two measures: the occurrence of preventable hospitalizations and early readmission after hospitalization. Preventable hospitalizations are hospitalizations for so-called ambulatory-care sensitive (ACS) conditions, such as asthma, diabetes, or hypertension (Billings, Anderson and Newman 1996; Bindman et al. 1995; Blustein, Hanson and Shea 1998). Hospitalization for ACS conditions are generally considered avoidable because if the patient's care had been better organized as an outpatient, the disease process could have been headed off at an earlier point, and thus the patient would not have had to be hospitalized for these conditions. The Agency for Healthcare Research and Quality provides a set of criteria to identify ACS-related conditions, which we applied to the diagnosis codes associated with inpatient claims to identify associated hospitalizations (Agency for Healthcare Research and Quality 2003). An early readmission is defined as an admission for the same principal diagnosis less than two weeks after the discharge of an earlier admission. If a patient is given good care in the hospital, he or she should not need to be readmitted for the same diagnosis within two weeks of discharge. It is generally argued that earlier readmissions are an indicator of suboptimal care in the hospital (Ashton et al. 1997). Taken together, the occurrence of preventable hospitalizations and early readmissions signal patients' inability to communicate with health care providers, provide complementary informal care at home, and coordinate formal and informal care. These measures may be particularly responsive to the presence of another individual in the household who can serve these functions, such as a spouse. These six measures of quality of health care have been widely used to assess the performance of physicians and health plans (National Committee for Quality Assurance 2006).

The unit of our analysis is person month. We generated a record for each month a person was alive during the study period; a person who survived until the end of the nine-year study period contributed 108 records to the analysis. For a given month, in terms of preventive services and chronic

care management, a person may be in one of three mutually exclusive states. Mammograms can serve as an example. In a given month, a woman between 65 and 74 years of age may have had a mammogram in the previous 12 months and therefore did not need to get a mammogram in that month. Conversely, she may not have had a mammogram in the previous 12 months and thus needs one that month; she may or may not get one. For each preventive measure, we generated two time-varying variables. The first variable indicates, in a given month, whether patients were “up-to-date” in terms of a preventive service, i.e., whether they received the recommended service in the previous 12 months. Among the patients who were not “up-to-date” and therefore were “at risk” for receiving that service, we generated a second variable indicating whether the patients received the service that month. The two variables are complementary, with one indicating the cumulative effect of accessing preventive services during a fixed period of time and the other indicating the action of the patient in a particular point in time. For the occurrence of preventable hospitalizations and early readmissions, we constructed time-varying variables indicating whether such an event occurred in a given month.

Statistical methods

Our analysis proceeds in two steps. The first step examines the effects of the transition to widowhood on indicators of the quality of health care. The dependent variables are whether an individual received a preventive service in a given month, given that he or she did not receive the service in the previous 12 months, or whether an individual had a preventable hospitalization, or an early readmission, in a given month. We use conditional logit models to obtain fixed-effect estimates. The equations used to model the occurrence of these events take the form:

$$\log\left(\frac{P(y_{jit} = 1)}{1 - P(y_{jit} = 1)}\right) = W_{it}\delta_j + X_{it}\beta_j + Z_{it}\gamma_j + \alpha_{ji}$$

where $P(y_{jit} = 1)$ is subject i 's probability of having event j (e.g. mammogram) in month t . W_{it} is a vector of 15 dummy variables indicating the amount of time preceding and succeeding spousal death (3

years or more, 2 years, 1 year, 7-12 months, 3-6 months, 2 months, and 1 month before spousal death, the month of the death, and the same time intervals after spousal death). The coefficients of W_{it}, δ_j , capture the trend in changes of quality-of-care indicators before and after spousal death for those who experienced spousal death.

Z_i and α_{ji} represent observed and unobserved time-invariant individual traits (e.g. gender); both Z_i and α_i were eliminated in the fixed-effect estimation. To assess gender differences in the effects of transition to widowhood on the use of health care, we examine the interaction terms between W_{it} and gender.

X_{it} is a group of time-varying control variables. We include dummy variables representing each of the nine years during the study period to account for the secular time trend. As individuals age, their consumption of health care in general increases; we account for the age effect by including dummy variables indicating incremental age grouped into two-year intervals. Age is measured in months; as a result, both age and year are identified in the fixed-effect models. Serious health conditions can distract individuals from paying attention to routine and preventive services; severity of illness has also been shown to be correlated with early readmission (Holloway, Medendorp and Bromberg 1990). We therefore controlled for time-varying indicators of health status. We used two years of inpatient claims prior to a given month to construct Charlson index³, which summarizes the illness burden in the month (Charlson et al. 1987). For this reason, individuals have to be at least 67 years of age as of 1993 in the analytical sample since younger persons did not have claims data for the entire period from 1991 to 1992. We also calculated the number of days an individual spent in the hospital in the year prior to a given month and the number of days an individual spent in the hospital in a given month as indicators of health status. For patients with diabetes, we also constructed and controlled for variables indicating whether an individual suffered from four types of diabetes-related complications in a given month, since diabetic monitoring typically intensifies as these complications emerge. The analysis of the occurrence of influenza

vaccination is limited to the months between October and February because the vast majority of the elderly is only “at risk” for influenza vaccination in these months. We included in this analysis dummy variables indicating the calendar month, as the probability of having influenza vaccination varies a great deal over the months. It is also possible that, as the frequency of hospitalizations increases, preventable hospitalizations are more likely to occur, other things being equal. We therefore controlled for the occurrence of hospitalizations that were not related to ACS conditions in a given month.

In the second step of our analysis, we tackled the question of whether quality of health care, as measured by our standard indicators, mediates the link between widowhood and elevated mortality risks. To examine whether quality-of-care indicators are mediators, we need to first establish that they are associated with both the mortality risks and being widowed. We therefore first evaluated the link between becoming widowed and quality-of-care indicators. We then assessed the mediating effect of quality-of-care indicators. To do that, we estimated the widowhood effect on mortality in models with and without indicators of quality of care and compared the estimates of widowhood effect on mortality in these nested models. To the extent that the widowhood effect decreases or disappears, we would detect a mediating effect (Clogg, Petkova and Haritou 1995). We used measures of preventive service delivery as markers of quality of care in the second step of the analysis. We used lagged and cumulative measures of quality of care in these analyses. That is, we used whether an individual obtained a particular preventive service in the year prior to a given month as quality indicators in this step of the analysis⁴. We did not include measures of preventable hospitalizations and early readmissions because these measures also tend to indicate health status⁵.

We applied a novel approach that estimates fixed-effect survival models of non-repeatable events, such as death. Two layers of confounding are not accounted for in conventional survival models. First, shared environment and behavior in a couple may affect the mortality of both the husband and wife. Mortality of the partner following spousal death may then be attributed to the shared traits rather than the death itself. Second, intrinsic individual traits, such as the ability to maintain a healthy lifestyle, may lead

to both appropriate use of health care and low mortality risks. An observed relationship between the appropriate use of health care and low mortality risks may at least partially reflect the confounding effect of individuals' intrinsic tendency, rather than the protective effects of high quality of health care.

To account for these potential unobserved confounders, we would ideally want to compare the mortality risk for the same individual over time; that is, we would want to perform a fixed-effect analysis of the mortality risk. However, death is a non-repeatable event. It always takes place at the end of the observation period, and therefore the survival status is a monotonic function of time. Conventional fixed effect models cannot provide valid estimates in this context. Hence, we employed the case-time-control method, which reverses the dependent and independent variables in the estimation of conditional logistic regressions (Allison and Christakis 2006). This method takes advantage of the fact that when both the dependent and independent variables are dichotomous, the odds ratio is symmetric. Therefore, reversing the dependent and independent variables produces the same result. Again the data are organized into person-month format. In the analysis of the effect of quality-of-care indicators on mortality, the dependent variable is a time-varying indicator of health care quality; the independent variable is the survival status in a given month and its coefficient indicates the effect of health care quality on mortality. In the analysis of the mediating effect of the quality of health care on the effect of widowhood on mortality, the dependent variable is a time-varying indicator of whether the spouse died during a specific interval of time (e.g. 1 month, 2 months, 3 months, 6 months, and 1 year) before a given month. The independent variable is again the survival status in a given month, and its coefficient denotes the effect of widowhood on mortality. We applied the case-time-control method with and without the time-varying quality-of-care indicators and assessed the changes in the widowhood effect on mortality in these nested models. Time-varying covariates can be introduced in these models. We controlled for the time trend and age.

RESULTS

Cohort attributes and descriptive statistics

Table 1 shows the eligibility criteria for receiving the preventive services and the size of the cohorts that met the eligibility criteria at the inception of the study stratified by whether the subject became widowed during the study period. Only those diagnosed with diabetes were eligible for diabetic monitoring; about 13% of the sample had diabetes at baseline. An annual mammogram is recommended for women between 65 and 74 years old. As they became older than 74 years of age during the follow-up period, they became ineligible for annual mammograms and were dropped from the analysis. We excluded anyone who had breast cancer or surgery of the breast at any time during 1991 to 2001. Table 1 also shows the rates of occurrences of quality indicators in 2001, which were well below the expected annual rates (100%).

<Insert Table 1 Here>

Table 2 displays summary statistics for select covariates at three levels: the person-month (for time-varying covariates), the individuals, and the residential context. The first three columns show the summary statistics for the entire sample, the non-widowed, and the widowed. Columns four and five display the summary statistics for diabetes patients and women who were eligible for annual mammograms.

<Insert Table 2 Here>

Trajectories of changes in quality-of-care indicators surrounding the transition to widowhood

We first addressed the question whether quality of care changed around the transition to widowhood. The average rates of diabetic eye exam and hemoglobin A1c monitoring among eligible diabetes patients in a given month were 3.6% and 2.5% respectively. On average, 13% of the individuals who were “at risk” for influenza vaccination got the vaccination in a given month⁶; 3.5% of the women eligible for a mammogram got it in a given month. The average monthly rates of preventable hospitalizations and early readmissions were 1.3% and 0.09%.

We explored the trajectories of changes in quality indicators by examining the coefficients of the dichotomized variables indicating the time intervals before and after spousal death. We hypothesized that the process of becoming widowed has a more negative impact on the quality of health care for men than women. To facilitate the visualization of the trajectories of the changes, Figures 1A-1F graph the estimated odds ratios of the occurrence of quality-of-care indicators relative to the baseline period (3 years prior to spousal death) during various time intervals before and after spousal death for men and women separately (except for mammograms, which are only applicable for women). Appendix A presents these odds ratios and their statistical significance. It also displays the likelihood ratio χ^2 tests for the overall statistical significance of the interaction terms between gender and the series of dichotomized variables indicating the time intervals before and after spousal death. The horizontal axis in Figures 1A-1F represents the months before or since spousal death; the vertical axis represents the odds ratio of event occurrence in a given month. The horizontal line in the figures shows the baseline level, and the vertical line marks the month of spousal death.

<Insert Figure 1A – 1F here>

Panels 1A-1C suggest little gender difference in the trajectories of changes in influenza vaccination or diabetic monitoring (A1c test and eye exam)⁷. At approximately 7-12 months before spousal death, the likelihood of receiving these services decreased significantly, which was then followed by a precipitous drop as spousal death approached; the nadir typically happened in the month when the death occurred. In the months immediately after spousal death, the rates of obtaining these services shot up; except for influenza vaccination, the rates rose significantly higher than the baseline rates. These trajectories diverged beyond the first three months following spousal death. The likelihood of obtaining influenza vaccination fell after the initial rise and remained slightly lower than the baseline. The likelihood of obtaining diabetic monitoring decreased steadily after the initial rise, and returned to the baseline level (dilated eye exams) or was slightly higher than the baseline (hemoglobin A1c tests) two years after spousal death.

Similar to influenza vaccination or diabetic monitoring, the likelihood of obtaining mammograms for women aged between 65 and 74 decreased as spousal death approached, reached the bottom in the month of spousal death and started to increase in the months following spousal death (Panel 1D). Unlike the other measures, the likelihood of mammogram occurrence remained high after the initial rise and steadily increased as the amount of time lapsed since spousal death.

Panels 1E-1F show large gender difference in the rates of preventable hospitalizations and early readmissions. In terms of preventable hospitalizations, the rates increased significantly about one year before spousal death for men but remained unchanged for women. During the month of spousal death, the rates of preventable hospitalizations spiked for both men and women and then gradually declined in the months immediately after spousal death. About six months after spousal death, the rates returned to the baseline level and became even lower than the baseline level after about two years into widowhood for women. For men, the rates remained much higher than the baseline level and started to steadily increase at about six months after spousal death. In other words, only the short-term shock of becoming widowed increased the risks of having preventable hospitalizations for women; however, men's risks increased during the whole process of transitioning to widowhood and remained higher than the baseline level long after spousal death (Panel 1E).

Similarly, widowed men were much more likely than widowed women to experience early readmissions. The rates of early readmissions spiked for both men and women at the time of spousal death, but for women these rates declined steadily, and returned to the baseline level three years after becoming widowed. For men, the rates declined at a much slower pace and remained much higher than the baseline level three years after spousal death (Panel 1F).

The quality of health care and widowhood effect on mortality

We consistently observed a decline in quality of health care before and at the time of spousal death, when the crisis caused by the pending death of the spouse was presumably unfolding. Moreover, the mortality risk for the newly bereaved was especially high; for example, a recent study found that the

hazard of death increased 52% for men and 62% for women during the first month of bereavement (Elwert and Christakis 2006). Our questions was whether neglecting one's health care needs when one's spouse was dying or after spousal death contributed to the subsequent elevated mortality risks during bereavement. Table 3 displays the survival status at the end of follow-up period by gender and widowhood for each of the cohorts that met the inclusion criteria for different quality measures⁸.

<Insert Table 3 here>

To assess the mediating effect of the quality-of-care indicators, we first examined the relationship between quality-of-care indicators and mortality. We then compared estimates of the hazard of death during various time intervals after spousal death in fixed-effect models of mortality without and with quality-of-care indicators. We found a negative relationship between the occurrence of quality-of-care indicators and mortality. Appendix B displays the odds ratio of death in a given month associated with being “up-to-date” on receiving a specific preventive service. The effects of preventive service on the mortality risk are quite large, as we argued that obtaining these preventive services is a marker of health care quality (Appendix B). A recent study of influenza vaccination in an elderly population also found large effects of the vaccination on cause-specific and all-cause mortality (Wang 2007).

Table 4 presents odds ratios of death of the surviving spouse during different time intervals after becoming widowed. Consistent with previous studies, individuals' risks of death increased significantly after the deaths of their spouses and remained elevated for up to two years. Odds ratios estimated from the base models (without the quality-of-care indicators) are similar in magnitude to those from models with quality-of-care indicators at all time intervals. That is, adding the quality-of-care indicators had little effect on the estimates of the widowhood effect on mortality for both men and women. Our investigation therefore suggests that the quality of health care, as we measured it, has little effect on the relationship between being widowed and the mortality risk.

<Insert Table 4 Here>

DISCUSSION

The transition to widowhood does indeed influence the quality of health care individuals receive. Past work suggests that the loss of marital benefits and the crisis caused by spousal death may combine to negatively affect individuals' abilities to maintain contact with health providers, advocate for themselves in the formal medical system, and coordinate formal and informal care (Umberson 1987; Williams 2004; Williams and Umberson 2004).

Our analyses support the crisis model, as the occurrences of quality-of-care indicators experienced significant fluctuation during the months surrounding spousal death. During the time leading up to spousal death, all quality indicators experienced a gradual but significant decline. This decline is likely indicative of the burden of spousal caregiving and/ or the loss of marital benefits due to spousal incapacitation. In the month when spousal death occurred, all quality indicators experienced a sharp drop, which may be attributed to acute bereavement and the need to manage the urgent and practical matters associated with the passing of a spouse.

In the months immediately after spousal death, the quality indicators improved, especially the rates of preventive service delivery and diabetic monitoring. At this time, newly widowed individuals intensified their interaction with the formal medical system; the rates and numbers of visits to both primary care physicians and specialists reached the highest point (results not shown). Consistent with the relief model, these trends may reflect a tendency of the newly widowed to compensate for earlier neglect of their health care needs. In addition, spousal death might remind them of their own vulnerability (Walter 2003). Or they might feel particularly unwell and think that health care providers can offer comfort and help; the physical manifestation of grief might lead the widowed to seek out the assistance of medical professionals, who might take the opportunity to perform routine and preventive services (Stroebe et al. 2001). Regardless of their motives, the newly widowed appear to have had enough resources to sustain a high level of contact with the formal medical system. Spousal death may have freed up household resources, in particular the time of the surviving spouse that used to be devoted to caring for the dying

spouse. It is also very likely that during the time following spousal death, the widowed experienced a surge of attention and support from their family and friends (Ha 2008). Future work will need to explore which of the foregoing mechanisms were operational.

It is more ambiguous whether our findings support the argument regarding the positive impact of marriage with respect to interaction with the formal medical system. First, being widowed proved not to have long-term detrimental effects on individuals' abilities to obtain preventive services. This is, losing one's spouse does not have sustained negative effect on one's abilities to maintain contact with the formal medical system. However, these findings do not imply that there are no marital benefits. It is plausible that internalized values and habituated behaviors acquired during the marriage continued to function without external sanction or motivation after spousal death. These findings also do not preclude the possibility that the marital benefits were partially lost after spousal death, but the surviving spouses were able to compensate for the loss, and gradually regain their abilities to maintain contact with the formal medical system. This scenario is consistent with the trajectory of changes in the likelihood of receiving influenza vaccination; after the precipitous drop at the time of spousal death and a large rise immediately after, the rate of influenza vaccination remained lower than the baseline level but gradually increased and approached the baseline level three years after spousal death. On the other hand, the rates of breast cancer screening and diabetic monitoring rose well above the baseline level following spousal death. In these cases, the depletion of marital benefits, if the depletion took place at all, seemed to have been overwhelmed by the intention to seek medical help and the availability of additional resources.

On the other hand, for men, the rates of preventable hospitalizations and early readmissions remained higher than the baseline level three years after spousal death. We suggest that whereas obtaining appropriate preventive services can be achieved through sustained outpatient interaction with the health care providers, more factors are involved in avoiding preventable hospitalizations and early readmissions. Preventable hospitalizations may be headed off with both sustained interaction with health care providers and adequate home and self care, as well as coordination between the formal and informal care. Early

readmissions may be prevented by good communication between the patient and doctor, competent discharge planning, and again adequate home and self care after discharge. As a result, avoiding these undesirable events may be more sensitive to spousal inputs.

We argue that the elevated risks for these undesirable outcomes suffered by men after they became widowed signaled the loss of marital benefits provided by the wives. What kind of marital benefits are lost? Our data do not allow us to tease out precisely whether the loss was tied to the wives' role in helping to maintain contact with the formal medical system, supporting self care and providing informal care at home, or helping coordinate formal and informal care. However, we observed that men did not differ from women in obtaining preventive services after becoming widowed. This suggests that when men became widowed, they lost help with self care and informal care as well as help with coordinating care needs; possibly they may have had to substitute that loss with formal care provided in the institutional settings of the health care system. The loss of marital benefits probably does not lie in promoting contact with the formal medical system, but in spouses' role as advocates, caregivers, and coordinators of health care. These gender differences highlight women's centrality in the household production of health (di Leonardo 1987; Powers and Bultena 1976). These findings may have practical implications since they identify important points of intervention for friends, family and social services in optimizing men's adjustment to widowhood.

The trajectories of changes in preventive service delivery generally suggested that there is little decline in the likelihood of obtaining these services after spousal death. But the long-term effects of being widowed on the rates of obtaining different preventive services did vary, which merits further consideration. Although vaccination, cancer screening, and diabetic monitoring are subsumed under the heading of preventive services, they serve different functions, and patients and doctors may attach different salience and urgency to different services. For example, practices of diabetic monitoring are associated with a chronic disease that has already occurred; they are preventive in the sense that they may slow the progression of the disease and prevent acute symptoms. Patients with diabetes may have adopted

diabetic monitoring as routine practices, and this routine may be reinforced by interactions with their doctors. The routine nature of diabetic monitoring could explain why, after experiencing the shock and aftermath of spousal death, the rates of diabetic monitoring stabilized at a level close to that before the onset of the process of transitioning to widowhood.

Cancer screening may become particularly salient to the widowed who were made acutely aware of their own mortality with the experience of spousal death (Walter 2003: p15); we may therefore observe an increase in the occurrence of post-widowhood mammogram. As a sensitivity analysis, we examined the trajectory of prostate cancer screening during the transition to widowhood for men aged between 65 and 74 and similarly observed an upward trend in the occurrence of prostate cancer screening after spousal death (results not shown)⁹. The idiosyncrasy of the mammogram trajectory therefore cannot be attributed to female gender. Among the preventive services under examination, only influenza vaccinations are generally applicable to both spouses. The fact that influenza vaccinations are actually relevant to both spouses might add to the importance of having a spouse to obtaining influenza vaccinations; for example, spouses may obtain these shots together. This may explain why the rates of influenza vaccination lingered slightly below the baseline level long after spousal death¹⁰.

We offer the foregoing explanations on why the long-term effects of being widowed varied across different measures of preventive service delivery. However our ability to use the available data to test the validity of these explanations is limited. More measures of different types of quality indicators would help differentiate the effects of being widowed from the nature of measures under examination.

Our second goal here was to examine whether the changes in quality of health care surrounding the transition to widowhood mediate the much-documented relationship between being widowed and elevated mortality risks. Although we found that quality of care fluctuated around spousal death and that the quality indicators were predictive of the mortality risk of the surviving spouse, our analysis did not detect any mediating effects of health care quality on the widowhood effect on mortality. This finding does not conform to the speculation in the literature on the detrimental effect of a decline in the quality of

health care due to widowhood. However, this study first shows that the pattern of changes in quality of health care surrounding spousal death is more complicated than that of a simple decline. Quality of care did experience a decline prior to and at the time of spousal death. But some quality indicators, in particular the use of preventive services, quickly recovered in the months following spousal death and in the long run, being widowed did not exert a strong negative influence on these indicators. Conceptually, this relatively short-term fluctuation in quality of care due to spousal death may still harm the health and survival of the surviving spouse. Empirical examination, however, suggests that this is not the case. Indeed, the mechanisms of the widowhood effect may be a fundamentally biosocial one that transcends the mere access to health care.

To our knowledge, this paper provides the most complete evidence regarding whether and how marriage confers a survival advantage by promoting quality of health care. However, quality of care is a multidimensional concept and our study is limited by the number and types of quality-of-care indicators in the available data. Further studies using measures of other dimensions of quality of health care are needed to confirm and extend the findings of this study. Nevertheless, the measures we used are known to be markers of health-care quality more generally, and, as such, should be taken as markers. We therefore concluded that changes in quality of health care during the transition to widowhood, as we measured it, did not have discernable impact on the elevated mortality suffered by the widowed.

NOTES:

1. Entry into marriage has been shown to deter crime (Laub, Nagin, and Sample 1998). Research in this vein illustrates the effects of micro-level social network on individuals' interaction with macro-social institutions. However, aside from the criminal justice system, little has been done to examine how marriage affects individual interaction with other formal institutions. In addition, not much is known about the effects of spousal loss.
2. A hemoglobin A_{1c} test is a lab test that measures the average amount of sugar (also called glucose) that has been in a person's blood over the last two to three months.
3. The Charlson index is a weighted sum of 17 conditions that have been shown to be predictive of mortality (Charlson, Pompei, Ales, and MacKenzie 1987).
4. Because the quality indicators are applicable to specific populations, for the person-months in which individuals are not eligible for a certain quality indicator, the quality indicator is set as 0. For the person-months in which individuals are eligible, the quality indicator is set as 0 if the individual obtained a particular preventive service in the year prior to a given month; otherwise it is set as 1.
5. Measures of obtaining preventive services may also be affected by health status. As a sensitivity analysis, we examined the mediating effects of quality-of-care indicators on the widowhood effect on mortality with and without controlling for time-varying indicators of health status. Controlling for indicators of health status does not affect the mediating effect of the quality of care indicators.
6. The monthly rate of influenza vaccination is higher than other preventive services because we only consider the flu season, between October and February each year, in our analysis. The occurrence of influenza vaccination is typically concentrated in these months.
7. The likelihood ratio χ^2 tests for the gender difference in trajectories of changes in Hemoglobin A_{1c} testing and influenza vaccination are not statistically significant ($p=0.60$ and $p=0.30$; two-tailed test). The test for the gender difference in diabetes eye examinations approaches statistical significance ($p=0.053$; two-tailed tests). However, given that we worked with very large samples, it is likely that

we would have found statistical significance even when the magnitudes of the differences were quite small (as shown in Figure 1 and Appendix A). These tests for statistical significance should therefore be interpreted with caution. Despite the relatively small p value from the likelihood ratio χ^2 test for the gender difference in diabetic eye exams, the findings suggest that the transition to widowhood had similar effects on the likelihood of obtaining these preventive services for elderly men and women.

8. The widowed in general were more likely to survive until the end of the follow-up period than the non-widowed, because by definition, the widowed had to survive their spouses. Conditional on survival to a certain time point, however, the hazard of subsequent death is in fact higher for the widowed than the non-widowed.
9. It has been suggested that men between the age of 65 and 74 should have annual prostate cancer screening. However, this suggestion has been highly controversial (Barry 2001). We therefore did not use this measure as a quality of care indicator in the paper, but only used it to corroborate the findings regarding mammograms.
10. To test this explanation indirectly, we separated a group of patients with diabetes whose spouses also suffered from diabetes and compared the widowhood effects on the practices of diabetic monitoring for this group and for diabetes patients whose spouses were free of diabetes. The rates of diabetic monitoring practices were higher for the diabetic couples at the baseline, but the trajectories of change during the transition to widowhood for the two groups paralleled each other (results not shown here). The diabetic couples might be able to help each other obtain appropriate services, and they were able to retain that advantage after becoming widowed; or the higher rates of diabetic monitoring among the diabetic couples were attributed to unobserved differences between the two groups. These findings do not offer evidence to support our speculation for the post-widowhood decline of rates of influenza vaccinations.

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Table 1. Eligibility Criteria for Quality-of-care (QOC) indicators, Expected Rates of QOC Indicators in 1 Year, Observed Rates of QOC indicators in 2001, and Cohort Sizes at Baseline

Quality Measures	Eligibility Criteria	Expected Rates of QOL Indicators in 1 Year, % ¹	Observed Rates of QOL Indicators in 1 Year, % ²	Cohort Size at Baseline	
				Non-Widowed	Widowed
Influenza vaccination	Age \geq 65 y	100	40	657,693	292,933
Mammography	Women aged 65-74 y; exclude those with cancer diagnoses or surgery of the breast	100	37	160,165	91,153
Diabetic eye examination	Medicare beneficiaries \geq 65 y diagnosed with diabetes	100	44	94,354	37,892
Hemoglobin A1c monitoring	Medicare beneficiaries \geq 65 y diagnosed with diabetes	100	56	94,354	37,892
Preventable hospitalizations	Age \geq 65 y	0	6.7	657,693	292,933
Early readmissions	Age \geq 65 y	0	1.4	657,693	292,933

1. Data represent the expected rates of the occurrence of quality of care indicators in one year. Rates are for the eligible populations.

2. Data represent the observed rates of the occurrence of quality of care indicators in one year. Rates are for the eligible populations.

Table 2. Descriptive Statistics for Select Variables by Widowhood Status and Cohorts

	All	Widowhood status		Mammography cohort	Diabetes cohort
		Non-widowed	Widowed		
Person-month level					
Hospital days in past year (mean)	8.9	8.4	9.9	7	8.1
Hospital days in the month (mean)	4.6	4.4	4.9	3.8	3.2
Charlson index (mean)	1.3	1.3	1.3	0.99	1.3
Number of diabetic complications (mean)	--	--	--	--	0.78
Individual level					
Age, y (mean)	75	74	75	70	75
Women (%)	49	41	67	100	48
African American (%)	9.1	9	9.1	8.8	14
Poor (%)	5.4	4.8	6.7	5.6	9.5
Residential context					
Urbanization index	68	68	68	68	67
% Black	8.9	8.8	9.4	9.1	11
Median Home Value (1000\$)	91,641	92,961	88,679	90,168	84,067
Median income, \$	30,383	30,658	29,765	30,318	29,229
Male unemployment rate	4.4	4.4	4.5	4.5	4.8
% Poor	13	13	13	13	14
% Less than high school	24	24	25	25	26

Table 3. Survival at the End of Follow-up by Gender and Widowhood Status in Eligible Cohorts (N(%))

	Non-Widowed		Widowed	
	Dead	Alive	Dead	Alive
Male				
All	219,074 (56)	169,771 (44)	48,932 (50)	49,191 (50)
Diabetes cohort	40,361 (71)	16,186 (28)	7,828 (62)	4,896 (38)
Female				
All	105,021 (39)	163,827 (61)	63,437 (33)	131,373 (67)
Diabetes cohort	23,234 (61)	14,573 (39)	11,794 (47)	13,374 (53)
Mammography cohort	46,096 (29)	114,069 (71)	18,773 (21)	72,380 (79)

Table 4. Odds Ratios of Death in a Given Month within Various Time Intervals after Spousal Death Estimated in Models with and without Quality-of-care indicators¹

Time after Spousal Death	Men		Women	
	Base Model ²	+Quality-of-care Indicators ³	Base Model ²	+Quality-of-care Indicators ³
1 Month	1.384	1.381	1.437	1.433
2 Months	1.328	1.325	1.315	1.311
3-6 Months	1.222	1.219	1.180	1.176
7-12 Months	1.255	1.253	1.159	1.157
2 Year	1.416	1.413	1.244	1.242

1. Estimates are generated by case-time-control models (fixed-effect models for non-repeatable events). All estimated odds ratios are statistically significant at $p < 0.001$ level (two-tailed tests).

2. The base models control for time trend and age.

3. Quality-of-care indicators are added to the base models.

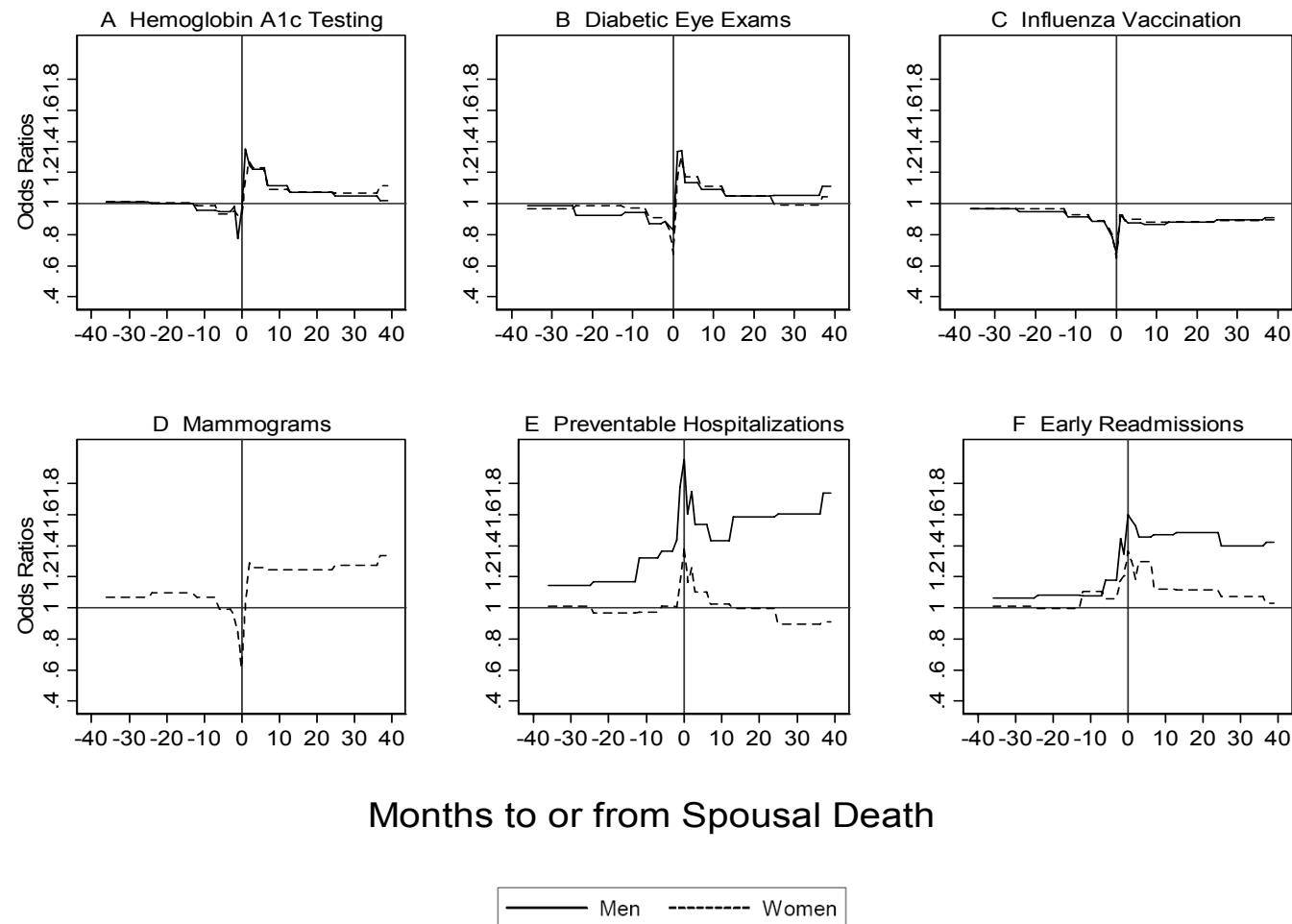


Figure 1. Trajectories of Changes in Quality-of-care indicators during Transition to Widowhood by Gender

The odds ratios of the occurrence of quality-of-care indicators in a given month within various time intervals before and after spousal death for men and women are shown, including hemoglobin A1c testing (Panel A), diabetic eye exams (Panel B), influenza vaccination (Panel C), mammograms (Panel D), preventable hospitalizations (Panel E) and early readmissions (Panel F). These estimates were generated in conditional logit models in populations eligible for the quality-of-care indicators. The horizontal line in the figures represents the baseline level and the vertical line represents the month of spousal death.

Appendix A. Odds Ratios of Occurrences of Quality-of-care indicators in a Given Month within Various Time Intervals before and after Spousal Death¹

Months before spousal death	Hemoglobin A1c monitoring		Diabetic eye examinations		Influenza Vaccination		Mammograms	Preventable hospitalizations		Early Readmissions	
	Men	Women	Men	Women	Men	Women	Women	Men	Women	Men	Women
25-36	1.02	1.01	0.99	0.97	0.97***	0.97***	1.07***	1.15***	0.99	1.06	1.01
13-24	1.00	1.00	0.93*	0.98	0.95***	0.96***	1.10***	1.20***	0.97	1.08	1.00
7-12	0.96	0.98	0.95	0.97	0.91***	0.93***	1.08**	1.37***	1.01	1.08	1.11*
3-6	0.95	0.93	0.88**	0.91*	0.89***	0.89***	1.01	1.49***	1.05	1.18*	1.06
2	0.97	0.95	0.89	0.88*	0.84***	0.85***	0.95	1.49***	1.09	1.45***	1.18*
1	0.78**	0.92	0.87	0.83**	0.78***	0.80***	0.86**	1.89***	1.20***	1.33**	1.20*
0	0.97	0.92	0.83*	0.68***	0.68***	0.65***	0.63***	2.00***	1.49***	1.59***	1.37***
Months after spousal death											
1	1.35***	1.15*	1.35***	1.16**	0.93**	0.95**	1.03	1.67***	1.25***	1.56***	1.30**
2	1.25**	1.27***	1.35***	1.3***	0.90***	0.89***	1.31***	1.79***	1.25***	1.52***	1.18**
3-6	1.23*	1.23***	1.15**	1.17***	0.87***	0.90***	1.30***	1.61***	1.06	1.45***	1.30***
7-12	1.12**	1.09*	1.10*	1.11**	0.87***	0.88***	1.27***	1.61***	1.04	1.45***	1.12*
13-24	1.07	1.07	1.06	1.05	0.88***	0.88***	1.30***	1.64***	1.02	1.47***	1.11*
25-36	1.06	1.06	1.06	0.99	0.90***	0.89***	1.33***	1.64***	0.92*	1.39***	1.08
>36	1.03	1.11*	1.12*	1.04	0.91***	0.89***	1.40***	1.89***	0.92*	1.41***	1.03
LR χ^2 test for gender differences ²	LR χ^2 (14) = 12.14	$p > \chi^2$ = 0.60	LR χ^2 (14) = 23.44	$p > \chi^2$ = 0.053	LR χ^2 (14) = 16.22	$p > \chi^2$ = 0.30	--	LR χ^2 (14) = 323.8	$p > \chi^2$ < 0.0001	LR χ^2 (14) = 49.22	$p > \chi^2$ < 0.0001

1. Estimates are generated by conditional logit models; all models control for time, age and indicators of health status.

2. Likelihood ratio Chi-square test for the overall significance of the interaction terms between gender and the series of dichotomized variables representing various time intervals before and after spousal death

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests).

Appendix B. Odds Ratios of Death in a Given Month Associated with Being "Up-to-date" on Receiving Specific Preventive Services^{1,2}

	Men	Women
Hemoglobin A1c monitoring	0.753	0.731
Diabetic Eye Exams	0.650	0.615
Influenza Vaccination	0.698	0.736
Mammograms	--	0.722

1. Estimates are generated in case-time-control models (fixed-effect models for non-repeatable events). All models control for time trend, age, and indicators of time-varying health status.

2. All estimated odds ratios are statistically significant at $p < 0.001$ level (two-tailed tests).